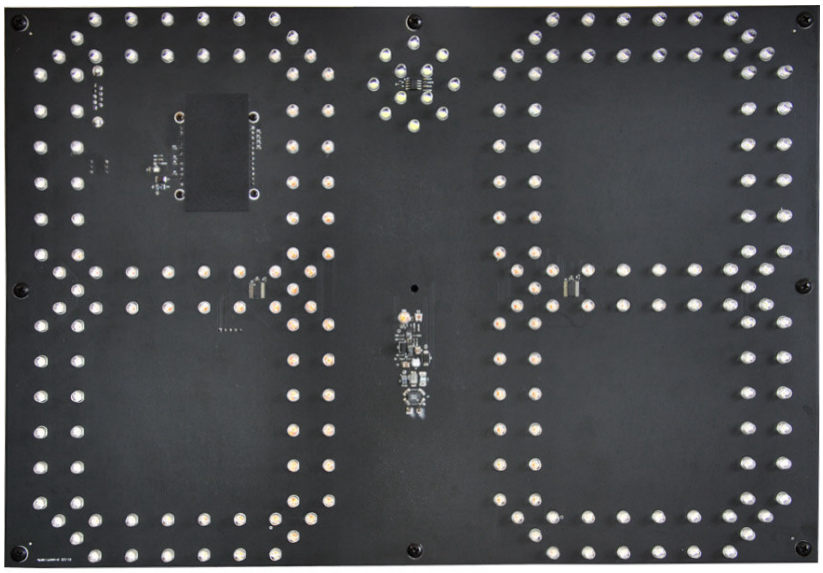
PNL10

OEM Radar Speed Sign Kit

Installation and User Manual

K-Band Doppler Speed Measurement and Display Kit
Rev 2 July 12th, 2010



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Doppler radar in this device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Any modification or use other than specified in this manual will strictly void the certification to operate the device.

The radar in this device carries FCC modular approval and as such is labeled with FCC ID TIASS300. If this label is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed SS300 module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID: TIASS300” or “Contains FCC ID:
TIASS300.” Any similar wording that expresses the same meaning may be used.

Warning: The PNL10 is supplied in an open frame format with exposed electronics and thus is a static sensitive device. Please use static precautions when handling. Warranty does not cover damage caused by inadequate ESD procedures and practices.

Note: Specifications may change without notice.
Note: Not liable for typographical errors or omissions.

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INTRODUCTION

Congratulations on your purchase of the Houston Radar directional Doppler radar speed sign kit PNL10. This state of the art two-digit speed display with integrated ultra-low power 24GHz K-band microwave Doppler radar is specifically designed for the license free solar power or battery operated speed sign and traffic calming sign market.

Utilizing high performance, ultra low power DSP (Digital Signal Processing) technology and microwave components based on a planar patch array antenna with integrated low power PHEMT oscillator, you will find that this high quality product meets your exacting standards for performance and reliability.

Some of the highlights of this product include:

- Zero cables highly integrated design assembles into your enclosure in minutes
- 10.5" (27cm) digit height with 30% inter-character separation is matched to 300+ ft (90+ m) detection range of the radar for optimal display legibility
- Best in class power efficiency achieved by:
  - Low power SS300 radar directly drives display thus eliminating display controller
  - Built-in ambient light sensing and automatic brightness control
  - Ambient temperature compensation of the LED drive voltage
  - High efficiency boost regulator for LED drive voltage
- When no traffic is present, the radar automatically powers down display further reducing power consumption to only 0.1W
- Wide input supply voltage operation allows flexible power supply options ranging from 3, 4 or 5 cell Lithium Ion packs to 6 or 12V Lead Acid batteries without sacrificing sign efficiency
- Built-in rotary switch allows user to set cutoff and violator speed alerts in the field without connecting to a computer
- White LED strobe light and display flashing can be optionally activated to draw attention to speeding
- An expansion connector allows addition of a third digit or a fixed custom external message, e.g "SLOW DOWN" when speed violation is detected
- Built-in radar is FCC approved with CE mark and available in 24.125GHz and 24.200GHz versions for worldwide deployment

INSTALLATION

PNL10 is supplied in an “open frame” format. It requires a weatherproof enclosure before it may be operated outdoors.

Direction Pointing:

The SS00 radar used in the PNL10 is directional in nature. It may be configured to detect and measure the speed of incoming or outgoing traffic. It then rejects traffic moving in the opposite direction. Direction of detection is configured via a bit in the MO variable in the radar. In the usual “speed sign” configuration the radar is set to measure and display speeds of incoming vehicles and is the default shipped from the factory.

To achieve optimal performance please follow a few simple rules:

- ✓ PNL10 should be pointed into the direction of the oncoming traffic.
- ✓ PNL10 should be placed along the size of the road to minimize the angle of the oncoming traffic to the sign.
    - If it cannot be placed right along the side of the road, it should be pointed at least 100-150 feet up the road into oncoming traffic.
- ✓ The radar in the unit may pickup rotating fans, compressor blades, etc. Avoid pointing it at any machinery containing moving parts.
- ✓ PNL10 should be mounted at least 3 feet high from the ground for proper operation and at least 5 feet high for maximum pickup distance
- ✓ PNL10 utilizes 15° viewing angle LEDs. For maximum visibility of the digits the sign should be pointed at the incoming traffic with better than 10° accuracy. Alternatively, the sign may be oriented towards traffic to maximize the LED brightness from the desired viewing location on the road. We suggest providing an adjustable mounting bracket for your enclosure that will allow at least a ±15° horizontal rotation to allow the user to make an adjustment during installation.

Recommended Enclosure for the PNL10:

The PNL10 display kit needs to be enclosed in a weatherproof enclosure for outside use. The following needs to be observed for optimal performance:

1. Any plastic cover or window in front of the unit may be mounted as close to the LEDs as desired. However, please consider any potential damage from flexing due to an external impact on the sign face (vandalism, etc.) being transferred to the PNL10. For maximum field reliability we recommend that you test the

proposed enclosure design to ensure the front face does not flex sufficiently to transfer an impact to the PNL10.

The PNL10 provides a clear hole in the center to allow you to pass a bracing standoff through it to transfer any face impact to the back of the enclosure. Do not mount the PNL10 using this center hole. The center standoff should be mounted from the rear of the enclosure and clear through the PNL10 display PCB and stop at the front face. This will allow any front face impact force to transfer to the rear metal wall of the sign enclosure.

2. The optimum material for the front window/face is Lexan (Polycarbonate) plastic.
3. The optimum thickness of polycarbonate window/sign face is half wavelength at 24.125Ghz or about 3.5 to 3.7mm thick.
    a. Commonly available ¼" thick Lexan is not optimal and will reduce pickup range. 3/16" thick Lexan is a better choice if the recommended thickness is not available. For metric sizes, 4mm thick Lexan is a reasonably good choice.
    b. Frosted (anti-glare) plastic have been successfully used as well. It does not matter which side (into the sign or into the traffic) the frosting faces and is left to your discretion.
4. Other plastic materials may be used as a front window, but the optimum thickness will wary with the material's dielectric constant. Please contact Houston Radar for details.
5. If you want to make a metal mask to hide the electronics on the PNL10 PCB with holes for the LEDs to pass through, you must provide a plastic window for the radar microwave beam to pass through. The location and size of this window is shown in Appendix A.
   A dxf drawing to use as a template for the metal mask is available. Please contact Houston Radar for the drawing.

We strongly recommend that you prototype and test your enclosure on the road to verify that the radar detection range is not affected by your choice of plastic and mechanical design prior committing to full production.

Hookup:

Power Input:

The PNL10 may be powered from a DC supply with output voltage between 5.6 and 18VDC. This allows great flexibility in power options including 6V or 12V (nominal) lead acid batteries (SLA), 3, 4 or 5 cell Lithium Ion (LiOn) or Lithium Iron Phosphate (LiFePO4) cells. In all cases, a highly efficient input power regulation system in the PNL10 adjusts the LED drive voltage to the optimum level required by the sign based on ambient temperature. There is no other speed sign in the world that even comes close to the resulting ultra-low power usage of the PNL10. Competing products may consume up to 5 to 10 times more power. This ultra low operational power translates directly into a longer battery life or gives you an option to power the unit from smaller batteries and smaller solar panels.

As an example of the PNL10's prowess, a 3 cell 96WHr ultra thin and light LiFePO4 battery pack weighing less than 1Kg will power the entire sign on the road for over 2 weeks of continuous operation! A convenient battery life calculator is available on our website to estimate the run time under different traffic and power supply situations.

Data/PC Connection:

The PNL10 features a standard RS232 interface that is used to configure the sign as explained later in this document. It also sends out the measured speed over this interface when a vehicle is detected which may be used to an external controller board to monitor the speed measured by the radar in the PNL10 kit.

Measured Speed Output:
The PNL10 will send out the measured speed via the ASCII interface as a 3-digit speed with an optional direction indicator in standard resolution mode. Extended resolution mode adds up to 3 digits after the decimal point. The format is:
[?,+]nnn[\r,\n] or in extended resolution mode [?,+]nnn[.n[n[n]]][\r,\n]
The format of the speed output can be adjusted to any combination of:
"?": Optional prefix sent when 000 selected to be sent when no vehicles are detected
"+": Optional prefix sent when nnn speed is sent for incoming vehicles
"nnn": Three digit ascii speed in the units selected via the UN variable
"[.n[n[n]]]": Optional decimal point with up to 3 digits of extended resolution selected via UN variable.
"\r": Carriage Return character, optional line ending
"\n": Line Feed character, optional line ending
Please see serial port configuration section for details on how to select the above format.

The radar used in the PNL10 is the Houston Radar SS300. Please see the SS300 user manual for more details on setting the output format and decimal point options.

IO Connector Signal Descriptions:

DB9 RS232 Female Connector:

Connector Pin #	Signal Name	Direction (wrt Radar)	Description
1	+VCC Note 1	PWR Note 1	Radar VCC (battery "+" terminal) Note 1
2	RS232 TX	OUT	RS232 Serial port TX pin from sign
3	RS232 RX	IN	RS232 Serial port RX pin into sign
4	N/C	-	Do not connect
5	GND	PWR	Signal/PWR Ground
6	N/C	-	Do not connect
7	N/C	-	Do not connect
8	N/C	-	Do not connect
9	N/C	-	Do not connect

Note 1: Pin 1 optionally connected to +VCC (supply +) if PCB pad labeled "DB9 PWR" near DB9 connector is bridged. This may be bridged by the OEM or by us if you require this feature.

AUX Connector:
You may optionally connect an off board speed selection switch, DB9 serial connection port or ambient light sensor.

Connector Pin #	Signal Name	Direction (wrt Radar)	Description
1	Vext0 Note 2	IN Note 2	External Light Sensor Input Note 2
2	+ VCC	PWR	Connected to input supply voltage +
3	B1	IN	External BCD speed switch B1 pin
4	RS232 RX	IN	RS232 Serial port RX pin into sign
5	GND	PWR	Signal/PWR Ground
6	RS232 TX	OUT	RS232 Serial port TX from radar
7	B4	IN	External BCD speed switch B4 pin
8	B2	IN	External BCD speed switch B2 pin

Note 2: Contact us for the part number and hookup schematic for the light sensor. Two different types of sensors may be used, passive LDR or active IC (recommended). Internal light sensor must be disabled by removing R24 on the front of the PCB in order to use an external light sensor.

USE

Turn on the power to the PNL10 to make it operational. The display will count up to from 1 to 10 and then blank out. The sign is now fully operational.

If the rotary speed switch is enabled (see later section on configuration), turn the speed switch to the desired position (0 through 7) determined by the speed limits on the road to set the low-speed display cutoff, violator display flashing speed and the high-speed display cutoff.

Typically, users set the violator flashing speed at or just above the speed limit on the road and the high-speed display cutoff at a speed sufficiently above the speed limit to capture most of the speeding traffic but not high enough to encourage “racing against the radar”. For example, for a 25mph speed limit road, the violator limit may be set to 26 mph and the low and high cutoffs will be set 15 mph below and above this value respectively. The exact values are of course left to the judgment of the user.

No other action is required. The PNL10 will display the measured speed when an incoming vehicle is detected between the low-speed and high-speed limits. The display will blink at about 1.4Hz rate if the measured speed is above violator speed. This indicates to the driver that they are driving above the speed limit.

If the white LED cluster is populated (this is the default, you may chose to have it removed), and enabled through the software configuration- it will strobe at a 10Hz rate. The strobe can also be configured to blink at 1.4 Hz rate when activated.

Finally, if the vehicle speed is above the high-speed display cutoff, the display will be blanked. This prevents drivers from “racing against the sign” (trying to see how high a speed they can display).

The strobe may be configured to stay active or go blank above this speed.

As long as the radar is tracking a target between the low-speed cutoff and the high-speed cutoff, the radar will transmit the speed in user selected ASCII format over the serial interface. This may be observed via our PC based configuration tool or captured by an external user provided controller board. Monitoring or capturing this speed is not required for normal operation of the speed sign.

Serial output is affected by low, high and violator speed configuration in the same way as the panel.

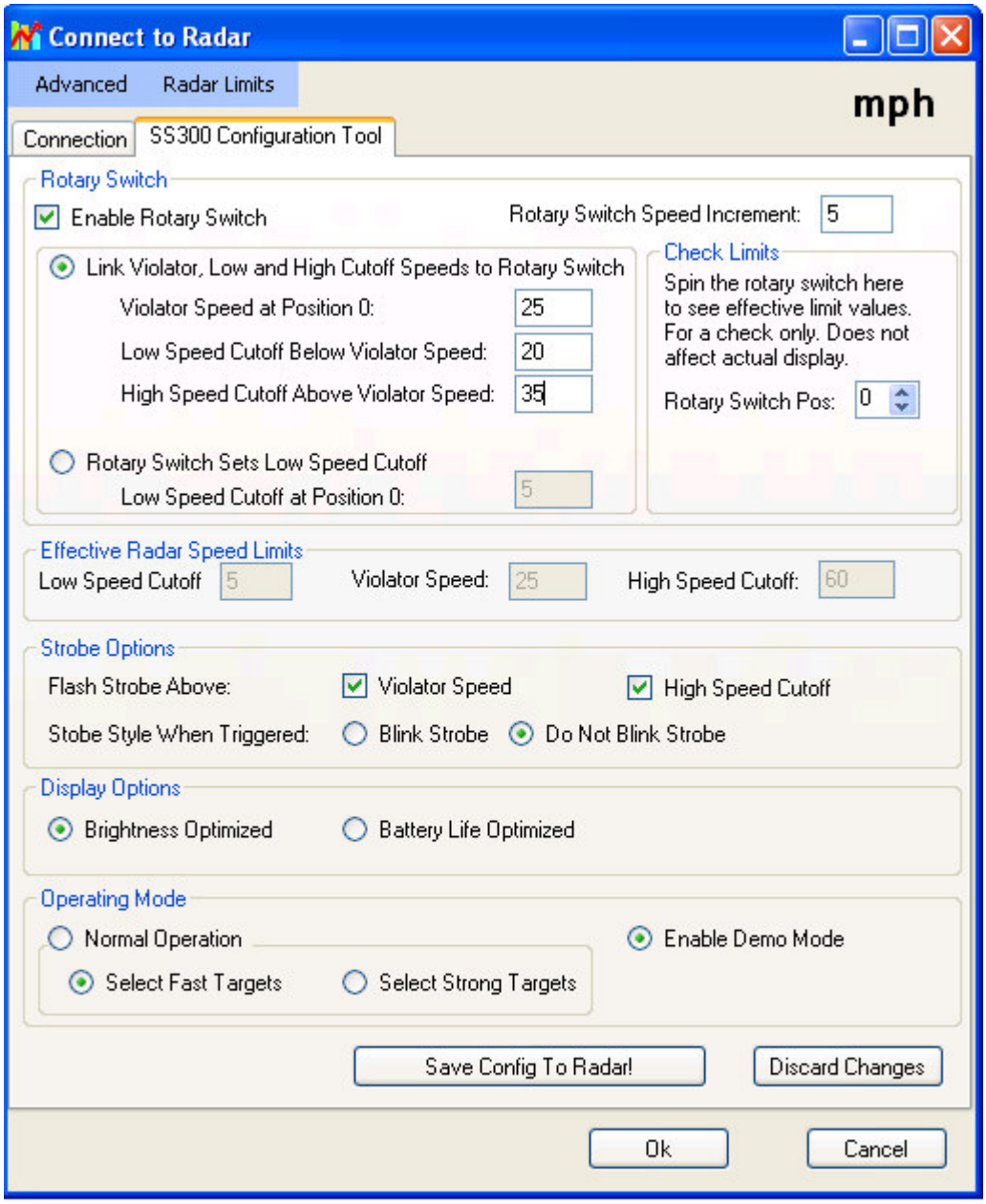
Triggering an External Custom Message:

The PNL10 makes it very easy for OEM's to connect an external custom LED string message like "SLOW DOWN" (or any string of LEDs arranged in a local language). This message can be activated whenever the strobe is active and will also blink if the strobe is configured to blink.

This configuration allows you to make a full functionality speed sign with a "SLOW DOWN" type message that is activated if the measured speed is above the speed limit or above the high-speed display cutoff. Please refer to Appendix B for a schematic of this simple external message board.

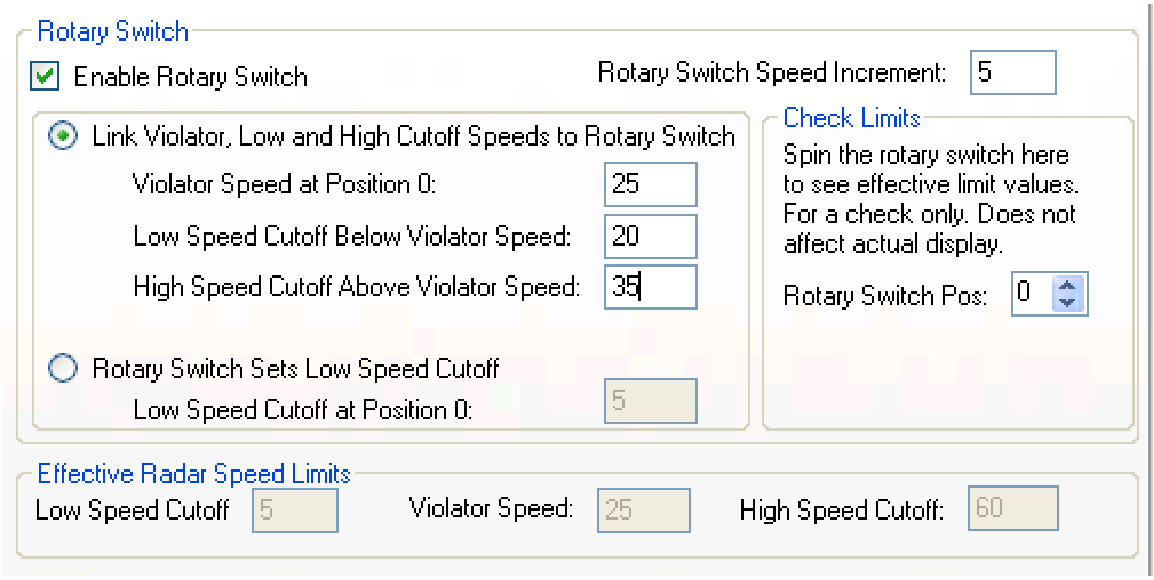
Configuring the PNL10:

The PNL10 supports many user options and configurations that make it a very versatile device. A user-friendly MS Windows PC based graphical user interface (GUI) software is provided to make this configuration a snap for the end user.



PNL10 Configuration Tool To Set Display Options

Rotary Switch Configuration


Rotary Switch
Enable Rotary Switch
Rotary Switch Speed Increment: 5
Link Violator, Low and High Cutoff Speeds to Rotary Switch
Violator Speed at Position 0: 25
Low Speed Cutoff Below Violator Speed: 20
High Speed Cutoff Above Violator Speed: 35
Rotary Switch Sets Low Speed Cutoff
Low Speed Cutoff at Position 0: 5
Check Limits
Spin the rotary switch here to see effective limit values. For a check only. Does not affect actual display.
Rotary Switch Pos: 0
Effective Radar Speed Limits
Low Speed Cutoff 5
Violator Speed: 25
High Speed Cutoff: 60

The above partial window-capture shows the configuration for the rotary switch installed on the rear of the PNL10.

You have three different options:

1. Enable the rotary switch and have it select the low-speed, violator speed and high-speed limits in the sign.
2. Enable the rotary switch and have it only select the low-speed cutoff. The violator speed and high-speed limits are then fixed and need to be provided in the "Effective Radar Speed Limits" window (which are now editable).
3. Disable the rotary switch completely and manually supply fixed values for all three limits. This option is for fixed installations where the sign will be mounted permanently in one location and you know what limits will be required for that location.

Option one above allows the rotary switch to control all three cutoff speeds in a "ganged manner" or linked manner. In the ganged mode, the single rotary switch will simultaneously move the low-speed cutoff, violator (speed limit) and high-speed cutoff speeds for the sign. To configure this option:
Set the violator speed you would like when the rotary switch is in position 0. This determines the minimum value.
Then set the offset of the high-speed cutoff above the violator speed and the offset of the low-speed cutoff below the violator speed.

Finally set the speed increment each turn of the rotary switch represents. The speed increment applies to all three speeds. The total adjustment range is defined by the product of the maximum switch value (7) and configured increment.

Now when you turn the rotary switch, all three speeds will move together as programmed by the user in this configuration screen.

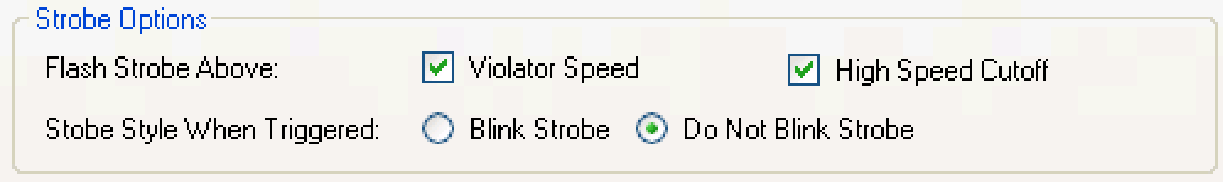
The "Effective Radar Speed Limits" box always shows simulated effective limits for the sign. You can spin a virtual rotary switch in the "Check limits" box to test what these speed limits will be for any possible value of the actual rotary switch.

Please note that spinning this "virtual" rotary switch does not affect the actual sign. To change the speed limits in the sign, the actual rotary switch on the back of PNL10 needs to be adjusted. The simulated values are provided as a tool to check what actual speed settings you will get when your configuration is saved to the sign.

Option two above allows you to control just the low-speed cutoff for the sign. Set the value you want with the rotary switch in position 0. The low-speed cutoff in all other positions will be determined by the switch position and the switch increment specified by the user. The violator and high-speed cutoff need to be manually supplied and will remain fixed even when the rotary switch is moved.

Option three disables the rotary switch completely and allows you to set all three limits to a fixed value. Turning the rotary switch will have no effect on the speed limits in the sign.

White Strobe Configuration



The PNL10 has a white LED cluster (strobe light) arranged in a circle in between the two digits. The cluster strobes at a 10Hz rate and may be selected to activate above the violator speed limit as well as above the high-speed limit. Both activation conditions may be independently selected. Note that if enabled above the Violator Speed, the cluster may also illuminate above the High Speed Cutoff.

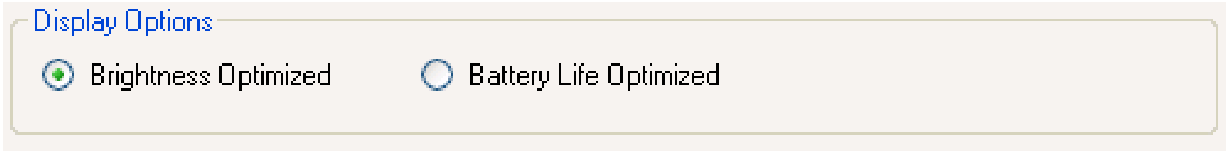
Strobe light is typically used to draw attention of the driver to the display and the fact that their current vehicle speed is above the posted speed limit or that they are driving at an unsafe speed.

The 10Hz modulation is implemented in the hardware and cannot be disabled via software. Contact Houston Radar if you require it to be disabled in hardware.

Additionally, this strobe can be configured from this screen to blink on/off at a 1.4Hz rate together with the speed display.

If you connect an external message as described in Appendix B, then that message is activated along with the strobe. Thus the strobe configuration options become the external message options as well. Note that the 10Hz strobing effect does affect the external message. However, the 1.4Hz blinking effect is propagated to the external message.

Display Brightness Configuration

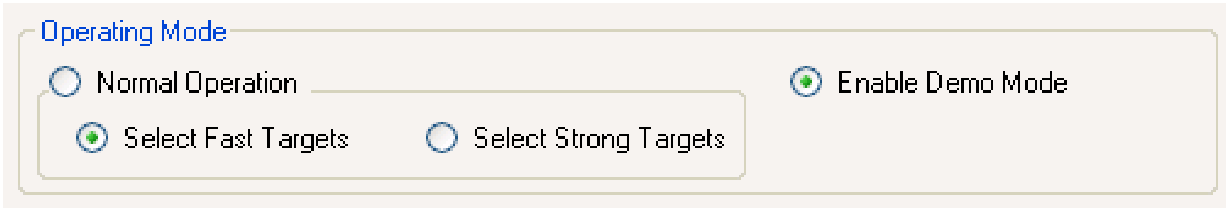


The PNL10 automatically controls the display brightness for optimal visibility under all ambient lighting conditions. The ambient light is sampled by a built in light sensor located on the front face of the PCB or by an optional external light sensor wired to the AUX connector. A control algorithm computes the optimal brightness and adjust the average LED current via a PWM circuit. PWM circuit is designed to prevent flicker and color distortion

You may chose to bias automatic brightness control algorithm towards saving battery (Battery Life Optimized) or making the display brighter and hence more noticeable (Brightness Optimized).

In the "Battery Life Optimized" setting the display brightness is reduced by about 30% from the factory default setting for any ambient lighting condition. This can be particularly advantageous for portable signs operating solely off a battery and allow the sign to operate up to 30% longer under heavy traffic conditions.

Operating Mode Configuration



For normal operation of the sign select "Normal Operation". In this mode, you may choose for the radar to pickup and display the fastest vehicle visible to it or the vehicle with the strongest return signal. Different customers have different preferences and you

may wish to try both settings in the field with actual traffic to determine which one you prefer.

The PNL10 also supports a “Demo Mode”. In this mode, the radar generates a pre-programmed sequence of speeds and shows them on the display. Note that the speed limits still apply to these speeds, so selecting different limits will change what speeds are displayed and if the strobe is activated. The ambient light sensor and automatic display brightness control work as normal. This can be a useful tool to test the sign on a low traffic road or inside an office or trade show floor.

In demo mode, the radar will not pickup and display actual traffic speeds.

Note: a power cycle a required for the change to take affect after going from Normal to Demo mode or vice-a-versa.

Additional Configuration Options

The radar utilized in the PNL10 is the Houston Radar model SS300. It supports numerous other options like detection sensitivity, programmable serial port baud rate, different measurement units (mph, kph, fps, mps) and fractional high precision speed output over the serial port.

If you wish to configure these options, we recommend that you read the SS300 user manual for more details. It is freely available for download on our website. These options require to set internal configuration variables directly through the procedure described in the SS300 user manual.

PNL10 SPECIFICATIONS

General

Operating Band	K-Band
Frequency	24.125 GHz ±50Mhz (US) or 24.20Ghz (UK, Australia)
Power Output	5mW
Antenna Beam Pattern	45 deg x 38 deg
Polarization	Linear
Supply Voltage	5.6V DC to 16V DC (18VDC Maximum)
Reverse Battery	Protected
Nominal Current Draw (@12VDC including radar)	Display blank: 9.5 mA Display at night: 21 mA Display at max brightness: 415 mA
Operating Temp.	-40°F to +185°F (-40°C to +85°C).
Weatherproof	No. User supplied enclosure required.
IR Remote Programmable	No

Approvals

Radar Approvals	FCC Part 15, modular approval (US Version), CE Mark.

Data Interfaces

Serial Communication	RS232
Data Rate	1200 to 115200 baud
Data Connector	DB9 Female with RS232 levels wired as a DCD. Use 3 wires straight through cable to PC RS232 port.
Power	Screw terminal default. Can be user specified. Minimum quantity order size may apply. Contact us for details.
AUX	2mm pitch 4x2rows. Sullins part # NPPN042GFNS-RC Use mating Sullins part # NRPN042MAMS-RC or equivalent

Optical

LED Color	ITE Amber (592nm ±4nm) for digits. White for strobe cluster *White LED digits are available as an option. Contact us for more information.*
Brightness	11,000 nits (cdm) maximum, controlled automatically via onboard light sensor 550nits at night minimum
Viewing Angle	15° cone off normal

Mechanical

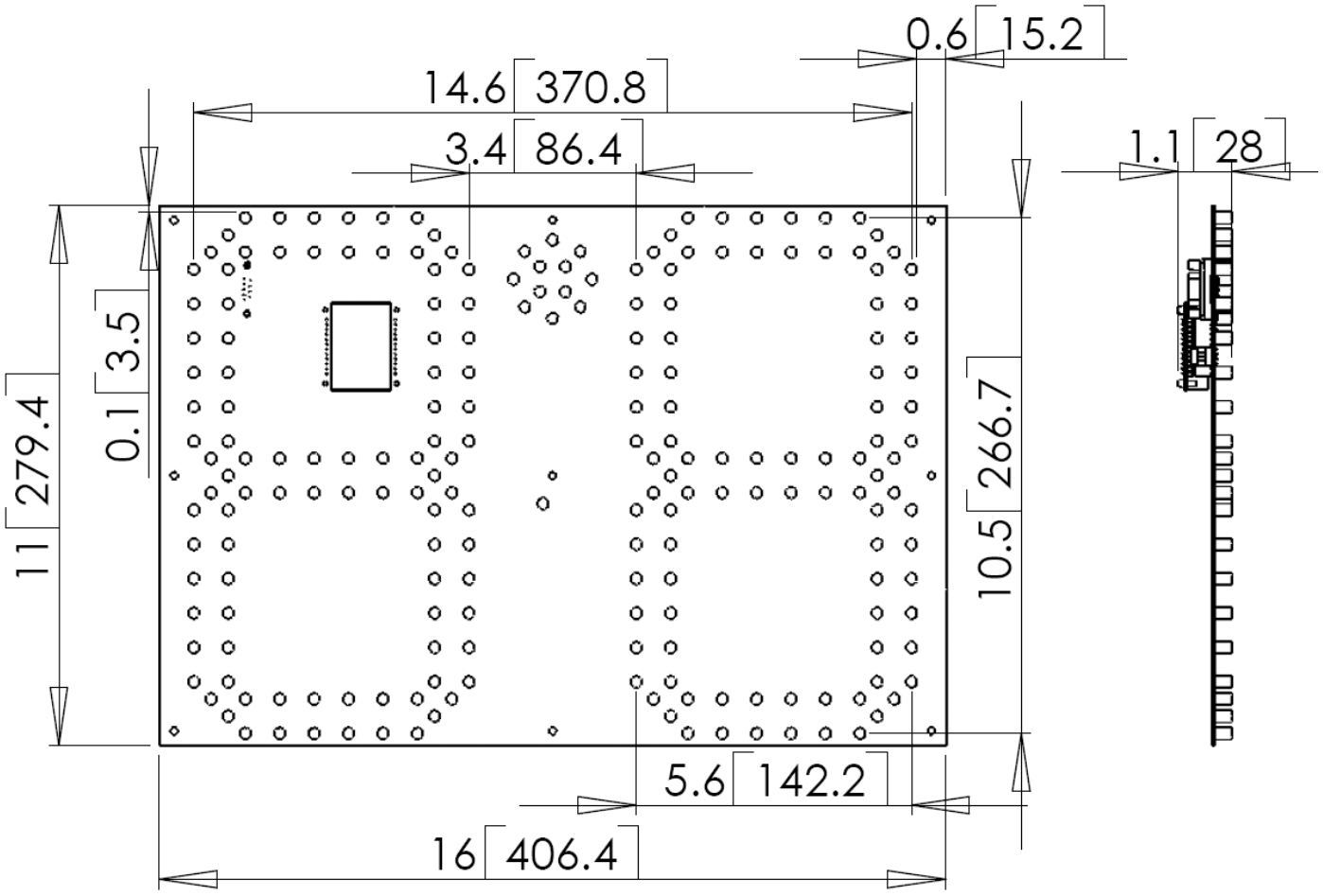
Weight	approx 450 grams (1 lbs)
Dimensions	11”x16”x1.1” (28 x 41 x 2.8 cm)
Mounting	8x #6 screw plated through holes connected to system GND. 1x #6 center non-plated hole for passing bracing standoff from the back. Do not use to mount PNL10 PCB.

Specifications continued on next page …

Performance

Resolution	±0.006 mph (internal and available on serial port) rounded to whole mph (kph) when shown on display.
Accuracy	±0.5% of reading + 0.1mph
Detection Range	Typically 90+ m (300+ feet) for compact vehicles on open and level road with radar mounted 1.5 m (5 feet) high and pointed straight into oncoming traffic. 150+ m (500+ feet) for larger trucks, lorries and vehicles with inherently large radar cross-section. May vary with installation and road conditions. Detection range specified is typical for speeds between 20kph and 88kph (12 to 55 mph). It tapers off below and above this speed range. At the low end of the speed range (2mph (5kph), the detection range is about 34+ m (110+ feet). PNL10 is not recommended for roads with speeds above 90 kph (56 mph) due to reduced range and tracking time. *Contact Houston Radar if a low speed operation (down to 0.25 mph) is required.*

Mechanical Outline Dimensions:



Rev 1.3 PCB. Dimensions in inches [mm]

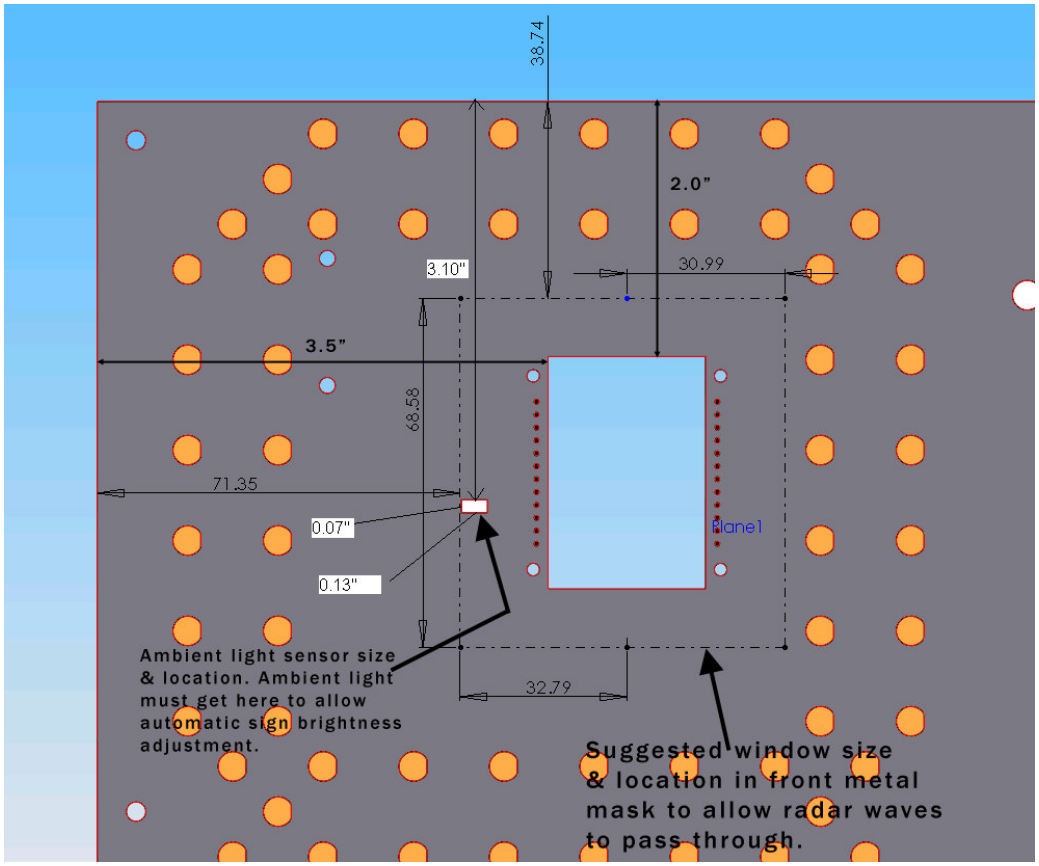
Appendix A: Plastic Window Location and Size When Using Front Metal Mask

If you chose to use a metal front mask (with holes in the LED locations to allow the LED's to show through), you must provide a plastic window for the radar beam to pass through. Use the drawing below for the recommended location and size for the plastic window in your metal mask.

The cutout in the PCB in the center of the figure is the actual size and location of the integrated SS300 radar. The dotted and dashed larger rectangle is the suggested window size.

The suggested window is larger than the actual radar because the radar waves diverge at a 38x45° angle from the face of the radar. The recommended window size is for a metal mask within a few mm from the top of the LED's. If the window is materially further away from this position a larger size window may be required.

Note: the white rectangle is an on-board light sensor. The light sensor is used to adjust the brightness of the LEDs based on ambient light conditions. You must allow ambient light to reach this sensor. Alternatively you may provide an external light sensor wired to the AUX connector on the back of PNL10. Contact Houston Radar for more details.

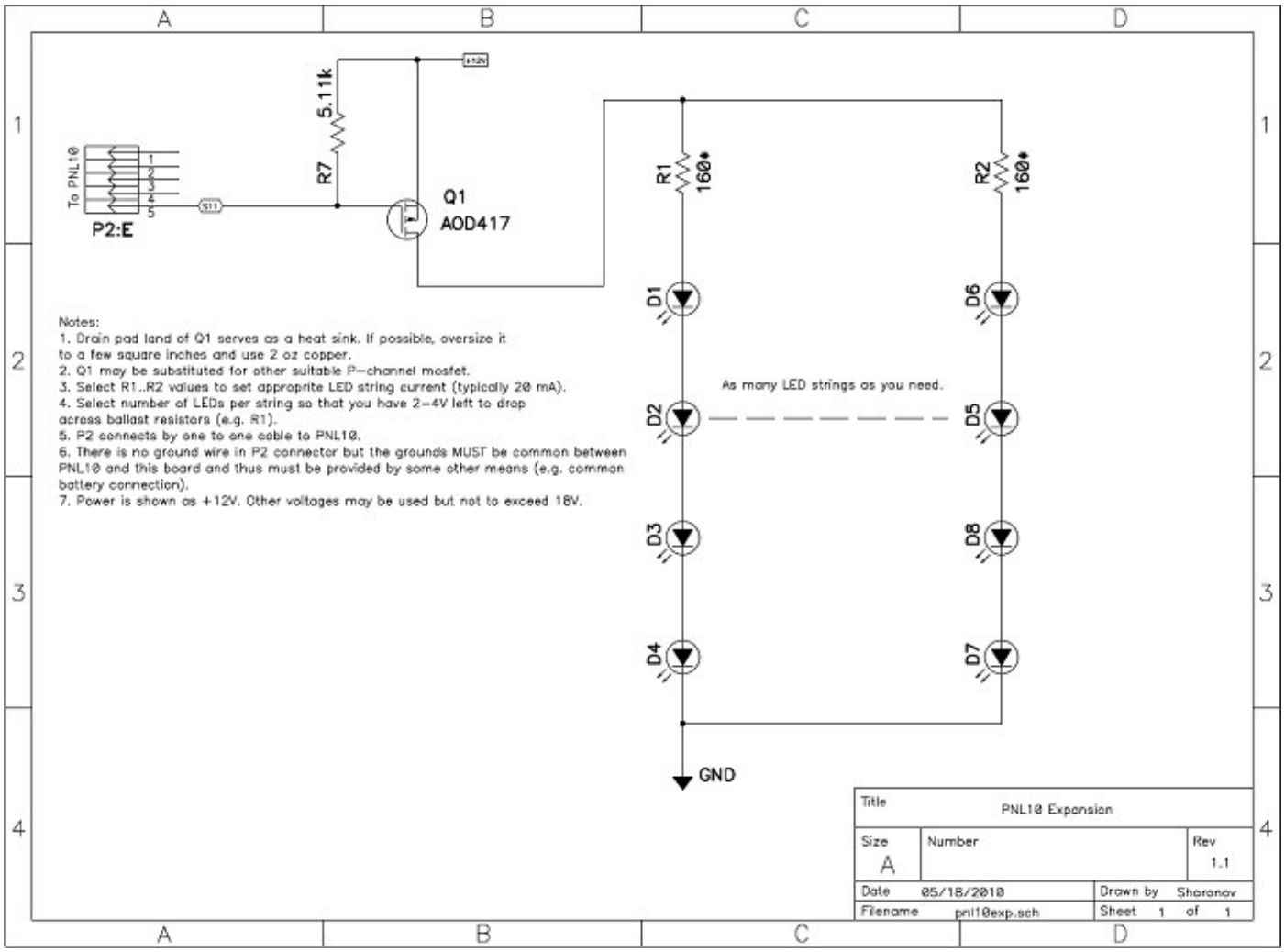


All dims in mm except those shown in inches (marked with a ").

Appendix B: Activate An External LED Message Above a Preset Speed

Many speed signs have an external VMS type message that gets activated above a preset speed. This message may spell out text like “SLOW DOWN” or any other message in a local language. The schematic below shows how to connect a string of LEDs that can be triggered by the PNL10 above a user set speed limit. The message is activated together with the on-board strobe. Additionally this message will blink if the user chooses the on-board strobe to blink. The 10Hz strobing effect does not apply to the message.

Connect as many strings of LEDs as required to form a message. For simplification only two strings are shown on the schematic. Then physically arrange the LED’s in the form of the message you desire. All LEDs will be lit when the on-board strobe is activated. The message can be programmed to activate above any user-selected speed. Furthermore this speed can be adjusted in the field through the rotary switch located on the back of PNL10. For most configuration purposes this eliminates the need to connect a computer in the field!



Appendix C: Expanding to an Optional 3rd Digit to Make a 3 Digit Speed Sign

You may easily expand the PNL10 to a 3rd digit (to show the 100's place value) via an LED only PCB. All the drivers are already built on the PNL10 PCB.
Note: The expansion connector to drive this 3rd digit is shared with the on-board strobe. Hence you must disable the on-board strobe for this scheme to work. Contact us for details on how to do that or please order your PNL10 without the white strobe populated.